will be to assist the interpretation of field facts and field experiments. For many reasons, this shifting of emphasis must be slow. Field methods must be developed and refined and students must be trained in their use. Field work demands instruments, base stations and much experience not for months but through years. In short, with these things, the field will become the real laboratory which must always be supplemented by secondary laboratories of histology, by plant houses, and the like. Each generation of botanical students is apt to feel that the beginnings of botany do not much antedate the beginning of its study of the subject. It sees and reads and does the things that are most recent and rarely dips into the past. It loses sight of the fact that development is of necessity a slow process and that most of the ideas and methods of to-day have a history. Hence, while the new generation is instructed to search diligently in the field and laboratory, it must not ignore the records of the past to be found in the books.

Following the open meeting, a regular meeting was held at five o'clock at which fifteen undergraduate students, who had been duly examined, were initiated in the preliminary degree of 'candidatus,' and four graduate students were promoted to the intermediate degree of 'novitius.' Thereafter, at six-thirty, a collation was spread in one of the laboratories to which a number of guests, members of the faculty of the university, had been invited. At the speaking after the collation, Dr. Pound presided. The speakers were Dr. Bessey, Dr. E. W. Davis, dean of the College of Arts, Dr. H. K. Wolfe, professor of educational psychology, and Dr. Bolton, professor of psychology.

PHYSIOLOGICAL ECONOMY IN NUTRITION.

IRVING FISHER, professor of political economy at Yale University, has been conducting experiments to discover whether proper mastication and enjoyment of food would produce the 'physiological economy' claimed for it by Mr. Horace Fletcher, and also whether it would lead to the use of low proteid according to the standard advocated by Professor Chittenden. The result of the experiment would seem to answer both these questions in the affirmative. The experiments were conducted with nine Yale students and lasted from January to June, 1906. Careful record of the amounts of food taken, and the constituents in, proteids, fats and carbohydrates, was kept for each man for each day. To avoid weighing at the table, the food was all weighed in the kitchen and served in 'standard portions' of 100 calories each or simple fractions or multiples thereof, so that the men merely needed to record the number of portions eaten. The proportions of proteids, fats and carbohydrates were found by means of the Mechanical Diet Indicator described by Professor Fisher in the *American Journal of Physiology* for April. During the first half of the experiment the men followed two rules only. The first was to thoroughly masticate the food up to a point of 'involuntary swallowing' with the attention, however, upon the taste and enjoyment of the food rather than upon the mere mechanical act of mastication. Any 'counting of chews' was discouraged as was also the forcible holding of food in the mouth, as experience of others, as well as the conclusions of Pawlow, had seemed to show that anything which tended to make eating a bore harmed rather than helped digestion. The second rule was to obey implicitly the leadings of appetite, both in regard to quantity of food and the choice between different foods. In order that this strict obedience to appetite might be the more easily followed, a wide range of choice of foods was supplied and no food was placed before the men which was not specially ordered by them.

This first half of the experiment, therefore, was really an experiment in natural eating, if we may assume that it is unnatural to hurry through our meals and to eat what is set before us, out of politeness, habit or limitation of choice. It was found that, as a consequence of the thorough mastication and obedience to appetite, a profound change occurred in the diet of the men. There was a large reduction in the quantity of liquids of all kinds at meals —water, tea, coffee and even soups. There was a reduction in the total daily average of

calories consumed of about 10 per cent., a reduction of proteids of about 15 per cent., and of flesh foods (meat, fowl, fish and shell fish) of about 40 per cent. During the second half of the experiment the two rules above mentioned were continued in force but a third was added. This was, when the appetite was uncertain in its choice of foods, to give the benefit of the doubt to the low proteid and non-flesh foods and to foods regarded, provisionally, as the most wholesome. This influence of suggestion was never carried however to the point of eating against appetite. This still remained supreme. Suggestion was used merely to settle cases where appetite was not decisive.

During the second half of the experiment there was a still more pronounced change in the character of the diet. Comparing the diet in June with that in January it was found that the total calories had fallen about 25 per cent., proteid about 40 per cent. and the flesh foods over 80 per cent. or to about one sixth of the original amount. Moreover the proteid had fallen to the level indicated as desirable in the previous experiments of Professor Chittenden, which is one and a half calories of proteid per pound of body weight.

Other physiological changes were noted. There was reduction in the quantity of the excretions and in the putrefactive and fermentative properties of the feces.

The body weights of the men during the first half of the experiment fell on an average of two pounds and in the second half fell further four pounds. Gymnasium tests were made to ascertain the strength and endurance of the men. It was found that their strength had remained practically constant through the experiment while their endurance increased during the first half about fifty per cent. and during the second half by as much more. A marked distinction was drawn between strength and endurance, strength being the utmost force which a muscle can exert *once* and endurance the number of times that a muscle can perform an exertion which is within its strength. Seven endurance tests were used: rising on the toes; deep knee bending; leg raising; raising five-pound dumb bells by the triceps; raising successively dumb bells of fifty pounds, twenty-five pounds, ten pounds and five pounds by the biceps; holding the arms horizontal and running. In many of these tests it was found that the will gave out earlier than the muscle; in short, that they were tests of grit, but in others it was found possible to work the muscles up to the point where they refused to contract further. Many precautions were taken to prevent any errors in these comparisons and only those records were used in the final averages in which the men were less tired in January than after the corresponding tests in June or records in which, both in January and June, the muscle was operated up to the point where it refused to contract. Even with all these precautions the improvement in endurance was found to be enormous. For instance, one of the men who in January could not raise a five-pound dumb bell with his triceps beyond the one hundred and eighty-fifth time, in June was able to do so 501 times, and another who could do the leg raising in January 50 times, in June could perform this 105 times; another who in January could lift the twenty-five-pound dumb bells with the biceps 10 times, in June could do so 27 times. The average improvement from January to June, making every possible allowance, was over 90 per cent. The men were not as stiff and sore after the June as after the January tests, in spite of the fact that they had performed double the amount of work.

So far as is known, no other than dietetic causes could have produced this result. The men led sedentary lives with less rather than more exercise than previously. They were no more regular in their habits and made no effort to live more hygienically except in the matter of diet. The dietetic factors were merely a wide range of choice of wholesome foods well cooked and appetizing, slow eating and obedience to appetite. As to which of these factors was the most important, and as to the manner in which physiologically they affected an improvement in endurance, there is much room for speculation. In the light of other facts it may at least be suspected

that one of the chief reasons for improved endurance was a reduction in proteid.

Mental tests were taken consisting of the addition of numbers, these showing slight increase in mental quickness.

A complete account of the experiments will be published shortly. It was undertaken by Professor Fisher in connection with a series of statistics which he is collecting on the subject of labor-power, especially in relation to diet, somewhat similar to the series of statistics collected by the economist Nitti some ten years ago. In communicating to the editor of SCIENCE the foregoing outline of his experiment, he has asked that any readers of SCIENCE who may be able to supply data on this subject from personal experience or other sources will put themselves in correspondence with him.

FIELD WORK OF THE SCIENCE DIVISION OF THE STATE OF NEW YORK.

GEOLOGICAL SURVEY.

Correlation Work.—The director and assistants continued the field investigations necessary to the comparative study of the New York Devonic faunas in their extension eastward. Explorations, resulting in considerable and exhaustive collections, were carried on in northern New Hampshire and Vermont, eastern Maine and in the Gaspé Peninsula, Canada. These field investigations, now completed, have brought to light a very large amount of instructive paleontological and stratigraphical data.

Areal Surveys.—The survey of the crystalline region of the Highlands of the Hudson has been continued. In the Adirondacks, a portion of the iron region of Essex County has been resurveyed and the Theresa quadrangle in Jefferson County well covered. In the area of exclusively sedimentary rocks, surveys have been made in the Lake Champlain Valley, and the following quadrangles in central and western New York have been advanced or brought to completion: Chittenango, Cazenovia, Syracuse, Geneva, Auburn, Nunda, Portage, Skaneateles and Phelps.

Surficial Geology.—Though somewhat interrupted by the absence of the geologists in charge, some advance has been made in the interpretation of the northern Hudson and lower Mohawk Pleistocene phenomena and in the survey of the morainal deposits of western New York.

Paleontology.—A discovery of singular interest is the occurrence of Eurypterus-bearing shales with a novel and extensive fauna in the Shawangunk Mountains of eastern New York. The age of the Shawangunk grit, commonly regarded as equivalent to the Oneida conglomerate (lowest Upper Siluric) of central New York has but recently been demonstrated on purely stratigraphic data, to be the probable equivalent of part or all of the Salina formations. Subsequent to this demonstration the Eurypterus fauna was found in the grit, confirming the stratigraphic deduction, as its species are in some measure those of the Pittsford shale which lies at the base of the Salina series in western New York. The fauna is distributed through nearly 700 feet of the grit deposits. The museum has been enriched by very extensive collections of these fossils. Large acquisitions have also been made from the Eurypterus localities of Herkimer County from the Chazy and Beekmantown limestones of Lake Champlain with some remarkable slabs of Cystideans and other fossils from the Trenton limestone of southern Ontario.

Economic Geology.—A careful reexamination of the iron regions and their ore bodies has been made with the definite purpose of indicating possibilities of future development. These operations have met with a result altogether unanticipated and have determined the presence of undeveloped ore deposits so extensive as to put the state in the first rank of iron-bearing regions of the country. Indeed it is now probable that no equal area contains more available undeveloped iron ore, now to be reckoned by some hundreds of millions of tons of fair to high grade ore representing a vast increase in the potential wealth of New York state.

Other metallic ore industries have also been exploited, an interesting example being the newly developed zinc deposits of St. Lawrence County. Special examination of the sand-